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Diving First Aid Training for Scientists

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Abstract

Theoretical and practical training for scientific diver certification is described in detail in the AAUS Standards for Scientific Diving (October, 2005). Among that is the required topic of diving emergency care training. A cornerstone of the OSHA scientific diving exemption is the diving safety manual, which includes, at a minimum, procedures covering all diving operations specific to the program, including procedures for emergency care, recompression and evacuation, and the criteria for diver training and certification. The Diving Control Board is vested with the autonomous and absolute authority over scientific diving program operations and specifically, shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the diving safety manual. The diver emergency care training components can be met through participation in training courses based on standards promulgated by outside organizations. However, these courses exhibit a significant overlap in curriculum content and are provided to the lay public as stand-alone classes. This does not meet the scientific diving community's need and constitutes an excessive investment of the diving scientist's time. As the point source science-based material repackaged by Cardiopulmonary resuscitation (CPR) training agencies periodically changes (Kern *et al.,* 2001), so must our approach to diving first aid training. The Academy's published standards for provision of diving theoretical and practical training contain material that far exceeds in complexity the

minimalistic, one-person adult CPR standards, which coupled with oxygen administration, forms the essence of the diving first aid procedure. We discuss the rationale for the establishment of an AAUS Diving First Aid Training course, and provide curriculum content.

Keywords: emergency care, safety education

Introduction

We propose to reduce the amount of unnecessary training time for the individual scientist, propose a training model that reduces overlap and consolidates this basic academic material, and encourage the scientific diving community to develop and control its own diving first aid training and performance standards.

Diving Officers continue to experience difficulty with continually diverging standards set by recreational diver training agencies and the AAUS standards for scientific diver training and operation of scientific diving programs, yet compliance with both is mandatory. Buddy breathing skills, swimming capabilities, and equipment configurations serve as examples. The time has come for the American Academy of Underwater Sciences to take control and reduce its total reliance on recreational diver training associations' standards through the creation of 'AAUS Scientific Diver' and 'AAUS Diving Safety Officer' certifications. Logic follows that an 'AAUS Diving First Aid' training curriculum be developed in conjunction with this effort, specifically tailored to the needs of the scientific diving community, with criteria on who can teach.

Perceived liability concerns for the AAUS in the promulgation of a diving first aid course should be considered. Account should be taken of the fact that the

agencies mentioned below all utilize the point source, science-based material published by the American Heart Association and the International Liaison Committee on Resuscitation (ILCOR). As a standard-setting agency, like it or not, AAUS already incurs liability exposure for the diving certification standards it sets.

Diving First Aid Components

In order to maintain active scientific diver status, a scientist must meet certain currency requirements, including diver emergency care training. This training has to date consisted of: a) cardiopulmonary resuscitation, b) standard first aid, c) recognition of decompression sickness (DCS) and arterial gas embolism (AGE) symptoms, d) accident management, e) field neurological exam, and f) oxygen administration. The provision of this training is in some instances provided by diving program staff of the home institution through standardized courses packaged by organizations such as the American Red Cross, American Heart Association, Divers Alert Network, American Safety and Health Institute, Professional Association of Diving Instructors and the National Safety Institute. Long-term scientific divers have the privilege of partaking in these courses in their entirety on an annual basis, investing approximately 16 hours of diving first aid training time. Some agencies require strict adherence to curricula standards and do not provide for refresher options for individuals who are within the one-year period of currency.

Preparedness: Effectiveness and Currency

Current training in diving first aid provides for a reasonable expectation of competency of being able to render time-

critical assistance to an injured dive buddy. For the scientific community, the primary rendering of aid (see Table 1) has been through oxygen administration, with the ability to provide cardiopulmonary resuscitation (CPR) in a stand-by mode. The efficacy of CPR following witnessed cardiac arrest has received much scrutiny in the last decade. Despite an overall increase in public preparedness for the administration of chest compressions following a heart attack, the average victim survival rate remains less than five percent (Weisfeldt and Becker, 2002; Wang *et al.,* 2005). However, despite this low survival rate, the overall public opinion regarding CPR is that it is a highly effective treatment for resuscitating heart attack victims (Jones *et al.,* 2000). So somewhere in the public CPR education and training programs there is a significant disconnect between expectations and reality. The probability of sudden cardiac arrest within the scientific diving population would be reasonably expected to be low due to the diving medical surveillance and periodic re-certification schedule that scientific divers are subject to.

One-Person Adult CPR

CPR as a rescue training procedure consists of a suite of assessment and intervention skills (American Heart Association, 2005). Execution of these skills by individuals that do not routinely provide emergency medical care is difficult. In a recent survey of the CPR readiness of 300 junior hospital physicians in the Netherlands, only 6% of these doctors could perform CPR correctly based on the Berden's International Criteria scale (Severien *et al.,* 2005). If medical professionals cannot reliably execute a CPR response, how can we expect scientific divers to be any more effective? Clearly there has been a problem with CPR education programs over the last two decades.

The recognition of this problem has prompted several re-evaluations of how CPR training can be more effectively executed. Because CPR is just one component of an emergency medical response, the first step in terms of public education is to simply establish clear triage guidelines for when CPR would and would not be potentially effective in treating a heart-attack victim. One basic conclusion of the low survivability statistics for ventricular fibrillation (VF) victims is that far too many CPR procedures were initiated in cases where there was little chance of success. There are several cardiac arrest etiologies that can lead to VF, such that there is not likely to be one optimal emergency medical strategy for all cases (Weisfeldt and Becker, 2002; American Heart Association, 2005).

The second step towards increasing the effectiveness of CPR rescue attempts is to adapt the assessment and intervention skills to the most essential components so that the most effective treatment course can easily be executed by scientific divers who have had annual diving first aid training. To this end, AAUS could adapt a video-based self-instruction (VSI) curriculum as has been developed by Lynch *et al.* (2005) that can be completed by a group of lay individuals in a 30 minute training session. Alternatively, a web-based training program could be made available. We strongly advise AAUS to adopt a standardized 12 month currency interval (versus 2-year validity as is the case in some states). In Lynch *et al.*'s VSI program, individuals without a CPR certification within the last five years were shown a 22 minute video and then worked on an inflatable manikin using an audio prompting device. In a comparative study of similar individuals given HeartSaver training, VSI students tended to have equivalent or better overall skills and ventilation performance. The key is to condense the essential elements of a CPR rescue into a simple package,

with the hope that divers will likely remember and execute an appropriate course of chest compressions and rescue breathing.

A third step towards increasing the effectiveness of CPR rescue attempts, focuses on doing what CPR is the most effective at doing: increasing blood perfusion to the brain in order to prolong the viability of the victim until emergency medical response professionals can arrive on scene. New guidelines for CPR have been recently adapted that prescribe a ratio of 30 compressions to two rescue breaths instead of the previously recommended 15:2 ratio (Chamberlain, 2005; Hazinski *et al.,* 2005; Hostler *et al.,* 2005).

2006 Changes to CPR Procedures

Recently, the American Heart Association and ILCOR published changes to basic life support, which should simplify the emergency response and make the care given more effective. Note that these guidelines neither support nor recommend against delivering oxygen to an injured diver. AAUS is encouraged to review these changes and modify them to appropriate dive-specific circumstances.

- Jaw thrust eliminated*:* head-tilt, chin-lift to be used in all instances.

- Rescue breath delivery: perform over one second, noticing the diver's chest rise through normal, not large or forceful breaths. Take 5-10 seconds to check for normal breathing in an unresponsive diver.

- Pulse check eliminated: during the initial assessment, two rescue breaths are now given followed immediately

by chest compressions (assumption is that a diver who has stopped breathing is also in full arrest.) Exception: professional rescuers are still checking for pulse and signs of breathing.

- Compression to ventilation ratio: one-person adult CPR now consists of 30 chest compressions followed by two breaths.

- Chest compressions: The emphasis on the quality of chest compressions is new; push hard and fast at a rate of 100 compressions per minute (approximately 2/sec) allowing the chest to recoil completely after each compression and similar compression and release times, minimizing interruptions.

- Automated external defibrillator (AED) use: delivery of a single shock followed by five cycles of compressions and ventilations (approximately two minutes). AED devices will need to be reprogrammed by the manufacturers due to this new recommendation.

Curriculum Overlap

A comparison of diving first aid component course curricula is provided in Table 1 showing the overlap in topics.

AAUS Diving First Aid Course Length

The time needed to conduct the diving first aid course varies and depends in part on the number of students, their pre-course preparation, and the amount of training material available to the Diving Officer. This course is skills

dependent, not time-dependent *per se*, and should not need to exceed eight hours of time for the initial course. The level of academic difficulty is negligible and our target audience is exclusively a population of scientists. Refresher or annual retraining sessions should take much less time to complete than the initial session, particularly for long-term scientific divers who have completed this requirement annually for many years. These shorter options for retraining could be considered a challenge, consisting perhaps of a brief review, a short multiple question test and acceptable demonstration of the required field neuro, oxygen administration, first aid and CPR skills.

Analysis of 16 reported AAUS incidents from 2002-2005 results in nine cases that were diving-related. The predominant diving first aid measure provided has been oxygen administration (Table 2).

First Aid at Remote Sites

Underwater work often takes us to remote field sites. Mention of the special diving first aid circumstances should be made during this course. Remote area field work (defined not only by distance, but also by time to treatment) may require dive team member(s) with advanced first aid qualifications in some circumstances. Contents of first aid kits at these sites need to reflect the types of hazards likely to cause injury. The components need to be organized in separate, color-coded compartments by injury with instructions (*e.g.*, CPR, medication, wound care, burn/blister, fracture/sprain, and bleeding). Such a system assists in locating what is needed quickly and keeps unneeded items clean and dry. Amounts and contents should be determined according to time/distance to a medical facility. Quantities of emergency oxygen should

also receive consideration with respect to numbers of divers, nature of anticipated dive profiles, and distance from advanced medical care.

Emergency evacuation and method of transportation, along with information on nearest hyperbaric treatment facility needs to be established a priori and enumerated in the dive plan. Methods of communication also need prior consideration and preparation (extra batteries, functionality test). This is often handled by satellite phones, cell phones and VHF radios.

Smithsonian Diving First Aid Curriculum

The following diving first aid curriculum has been in place at the Smithsonian Institution's Scientific Diving Program since 2000. It has proven effective as reflected by skills evaluations, theoretical knowledge, and training time efficiency. This curriculum could be evaluated by the AAUS Standards Committee for use as a template for an AAUS Diving First Aid course.

A. Legal and Ethical Issues

- Liability
- Negligence
- Standard of care and duty
- Assumption of risk
- Insurance and the 'Good Samaritan'

B. Diving Injuries

- Cause, signs and symptoms, treatment of: barotrauma, decompression sickness, arterial gas embolism, near drowning

C. CPR

- General health issues: importance of oxygen, stroke, AGE, blood loss, rescuer protection

- Heart problems: signs and symptoms, risk factors, atherosclerosis, angina, heart attack
- AEDs: recognition of warning signs of sudden cardiac arrest; basic life support and AED setup and support; care and maintenance of AED
- Stroke: cause, signs and symptoms, risk factors
- Rescue breathing
- CPR: scene assessment, alerting emergency medical services (EMS), airway management, breathing and ventilation, circulation and compressions, ongoing assessment
- Vomiting
- Airway obstruction
- Starting and stopping CPR
- Practical skills training

D. Diver First Aid

- Shock: recognition, management, treatment
- Bleeding: pressure points, immobilization techniques
- Gas toxicity
- Eye injury
- Seasickness
- Heat-related illness: signs and symptoms, and treatment for: heat cramps, heat exhaustion, heat stroke
- Cold-related illness: signs and symptoms and treatment for frostbite and hypothermia
- Near drowning
- Marine life injuries

E. Oxygen Administration

- Assessing the scene and oxygen provider safety
- Deployment, assembly, disassembly, and administration of the delivery components of an oxygen unit (demand inhalator valve and mask, constant-flow, non-rebreather mask, oronasal resuscitation mask with supplemental oxygen inlet, bag-valve-mask and positive pressure inflation)

F. Field Neurological Examination

- Taking a history
- Taking vital signs
- Mental function
- Cranial nerves
- Motor function
- Sensory function
- Balance and coordination

G. Marine Life Injuries

Conclusion

The current first aid and CPR certification requirements for scientific diving are not as effective as they could be for preparing individuals to handle diving accidents requiring an emergency medical response. The inefficiencies of the course curricula offered by major external training agencies include:

1. Longer in-class hours than are necessary to teach an effective course;
2. Curricula designed for a general public with extraneous content unrelated to diving emergencies;

3. Two-year certification intervals between refresher courses; and,
4. Increasing complexity of accident scene management and emergency responses that ultimately are more likely to decrease the survival probability of a victim when treated by a lay responder.

Given the inherent low probability of success of CPR when treating a victim without a heart beat, we propose that AAUS develop its own diving first aid training program designed to maximize the chances for survival in a diving medical emergency. The following are the primary advantages we envision:

1. **Simplified medical response with the greatest chance of success:** the best strategy for increasing the probability of a victim's survival is to maintain circulation of oxygenated blood to the brain until emergency medical personnel can intervene;

2. **Annual refresher training requirement:** scientific divers must be able to engage in a diving accident management mode as quickly as possible. First aid measures should be provided reliably and according to the precepts of the diver's training. A 12 month period would appear to be the maximum timeframe allowable to keep these skills current and effective;

3. **Standardized curricula:** adopting a specific AAUS diving first aid training program would ensure that all scientific divers in a program have received the same training, analogous to the overall diving reciprocity concept;

4. **Complete focus on diving emergency scenarios:** the training time and effort should be narrowly focused on this one objective;

5. **Less in-class training time:** new curricula formats in public training programs have clearly demonstrated the efficacy of reducing instruction time to keep participants focused on the course content. An AAUS diving first aid training program would prepare divers to be more effective responders in less time than public training programs.

Table 1. 'Diving First Aid' component course curricula

		DAN O2	DAN Field Neuro	AHA Heartsaver First Aid	AHA Heartsaver CPR, AED Adult onl
Approx. Time		4 hours	4 hours	3 to 4 hours	3 hours
Legal & Ethical Issues				X	X
Scene Safety & BSI		X		X	X
EMS Activation		X		X	X
Cardiovascular Physiology		X			
Diving Physiology		X	X		
O_2 Equipment & Safety		X			
Benefits of:	O_2 administration	X			
	Early defibrillation				X
Recognition of:	Cardiac emergencies			X	X
	Respiratory emergencies			X	X
	Stroke			X	
	Shock		X	X	
	Decompression sickness	X	X		
	Arterial gas embolism	X	X		

	Near-drowning	X	X		
	Choking			X	
	Medical emergencies			X	
	Traumatic emergencies			X	
	Environmental emergencies			X	
Assessment of:	Airway	X			X
	Breathing	X			X
	Circulation	X			X
	Neurological deficit		X		
Demonstrated Skill:	CPR				X
	AED				X
	O_2 administration	X			
	Choking rescue			X	
	Bleeding control			X	
	Shock control			X	
	Taking medical history		X		
	Taking vital signs		X		

Table 2. AAUS incident data as reported for 2002-2005.

Year and Incident Cause (no. of cases)	O_2 Admin	CPR	Rehydration	DCS	Recompression	Notes
2002 (n=11)						
rapid ascent	yes	no	yes	yes	USNTT6	
other	yes	no	no	no	no	
other	yes	no	yes	yes	USNTT6	
barotrauma	yes	no	yes	no	no	
other	yes	no	i.v.	yes	USNTT6	
2003 (n=2)						
other	no	no	no	yes	USNTT6+	
cuts	no	no	no	no	no	topical ointment
2004 (n=3)						
multiple ascents	yes	no	no	yes	yes	
rapid accents	yes	no	yes	no	no	rescue breathing
2005 (n=0)	n/a	n/a	n/a	n/a	n/a	

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